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HEWLETT PACKARD

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Operation
and
Service
Manual

HP 11970 Harmonic Mixers
K/A/Q/U/V and W Models

HEWLETT PACKARD

OPERATION AND SERVICE MANUAL

11970 SERIES HARMONIC MIXERS (K, A, Q, U, V, and W Models)

SERIAL NUMBERS

This manual applies directly to HP 11970K, A, and U mixers with serial numbers prefixed 2332A, to HP 11970Q mixers with serial numbers prefixed 2407A, and to HP 11970V and W mixers with serial numbers prefixed 2521A.

For additional important information about serial numbers, see MIXERS COVERED BY MANUAL in Section I.

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SECTION I GENERAL INFORMATION

INTRODUCTION

The HP Models 11970K, 11970A, 11970Q, 11970U, 11970V and 11970W are general-purpose harmonic mixers with very flat frequency response characteristics and low conversion loss. Collectively, they cover the frequency range of 18 to 110 GHz. The HP 11970K covers the 18 - 26.5 GHz range; the HP 11970A, the 26.5 - 40 GHz range; the HP 11970Q, the 33 - 50 GHz range; the HP 11970U, the 40 - 60 GHz range; the HP 11970V, the 50 - 75 GHz range; and the HP 11970W, the 75 - 110 GHz range. The overall local oscillator (LO) frequency range of the HP Model 11970 Series Mixers is 3.0 to 6.1 GHz. Each of the mixers employs a different LO harmonic, and as a result has a different optimum LO range within the overall LO range of the series. The LO ranges of these mixers make them fully compatible with the HP Model 8566A/B Spectrum Analyzer. HP 11970 Series Mixers use the HP 11975A Amplifier to raise the LO power to their required LO input level of +14 to +18 dBm. By taking advantage of the power leveling capability of the Model 11975A, the mixers are able to achieve maximum measurement accuracy (at optimum LO input level of +16 dBm).

A label on the top of each mixer shows a Conversion Loss Calibration graph plotted especially for that particular mixer. An 8-1/2 by 11-inch calibration table shipped with the mixer provides a larger, easier to read, version of the same graph shown on the label, plus a list which shows the conversion loss and reference level offset at significant points across the mixer's frequency range. This calibration table, accurate to ±2 dB, can be employed for absolute amplitude measurements. Also supplied with each mixer are five screws (four required) for attaching the mixer RF input flange to the waveguide.

MIXERS COVERED BY MANUAL

Serial Numbers

Attached to your mixer is a label which shows both the mixer model number and its serial number. The serial number is in two parts. The first four digits and the letter are the serial number prefix; the last five digits are the suffix. The prefix is the same for all identical mixers; it changes only when a change is made to the mixer. The suffix, however, is assigned sequentially and is different for each mixer. The contents of this manual apply to mixers with the serial number prefixes listed under SERIAL NUMBERS on the title page.

Manual Updating Supplement

A mixer manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the mixer is different from those described in this manual. The manual shipped with this newer mixer is accompanied by a yellow Manual Updating supplement. This supplement contains change information which explains how to adapt the manual to the newer mixer.

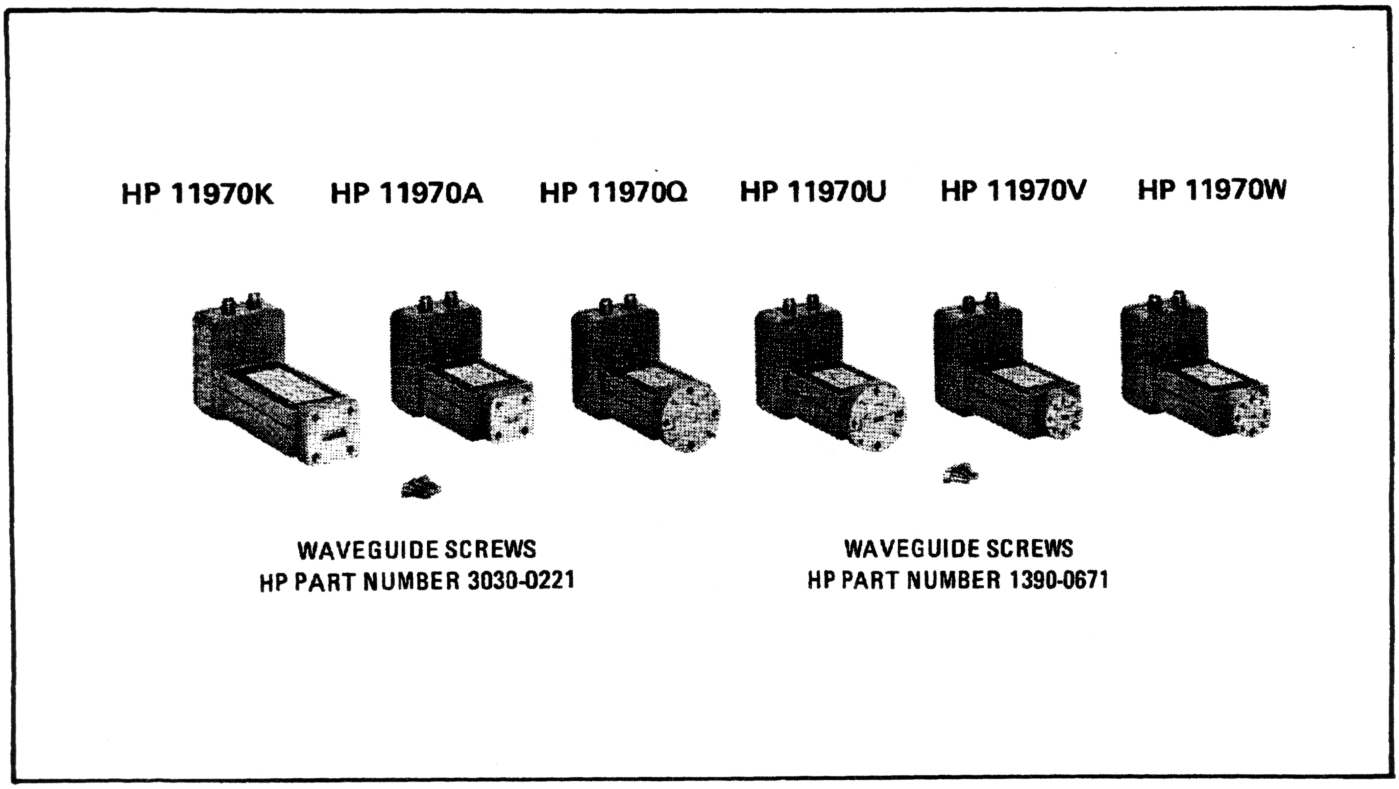


Figure 1-1. HP 11970 Series Harmonic Mixers

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Updating supplement. The supplement for this manual is identified with this manual's print date and part number, both of which appear on the manual title page. Complementary copies of the supplement are available from your nearest Hewlett-Packard office. Addresses of major offices worldwide are listed on the inside rear cover of this manual.

For information concerning a serial number prefix that is not listed on the title page or in the Manual Updating supplement, contact your nearest Hewlett-Packard office.

OPTIONS

Option 009, shown in Figure 1-2, is a Mixer Connection Kit. It includes three low-loss SMA cables (HP Part Number 5061-5458), one hex-head balldriver (HP Part Number 8710-1539) for tightening the waveguide connector screws, and one 5/16-inch open-end wrench (HP Part Number 8710-0510) for use on the SMA connectors.

SPECTRUM ANALYZER RETROFIT REQUIREMENTS

The Model 11970 Series Mixers are fully compatible with all HP Model 8566B Spectrum Analyzers and all 8566A Spectrum Analyzers having RF Sections with serial number prefixes 2007A and above. 8566A Spectrum Analyzer RF Sections with serial number prefixes lower than 2007A require two changes to adapt them for use with the Model 11970 Series Mixers.

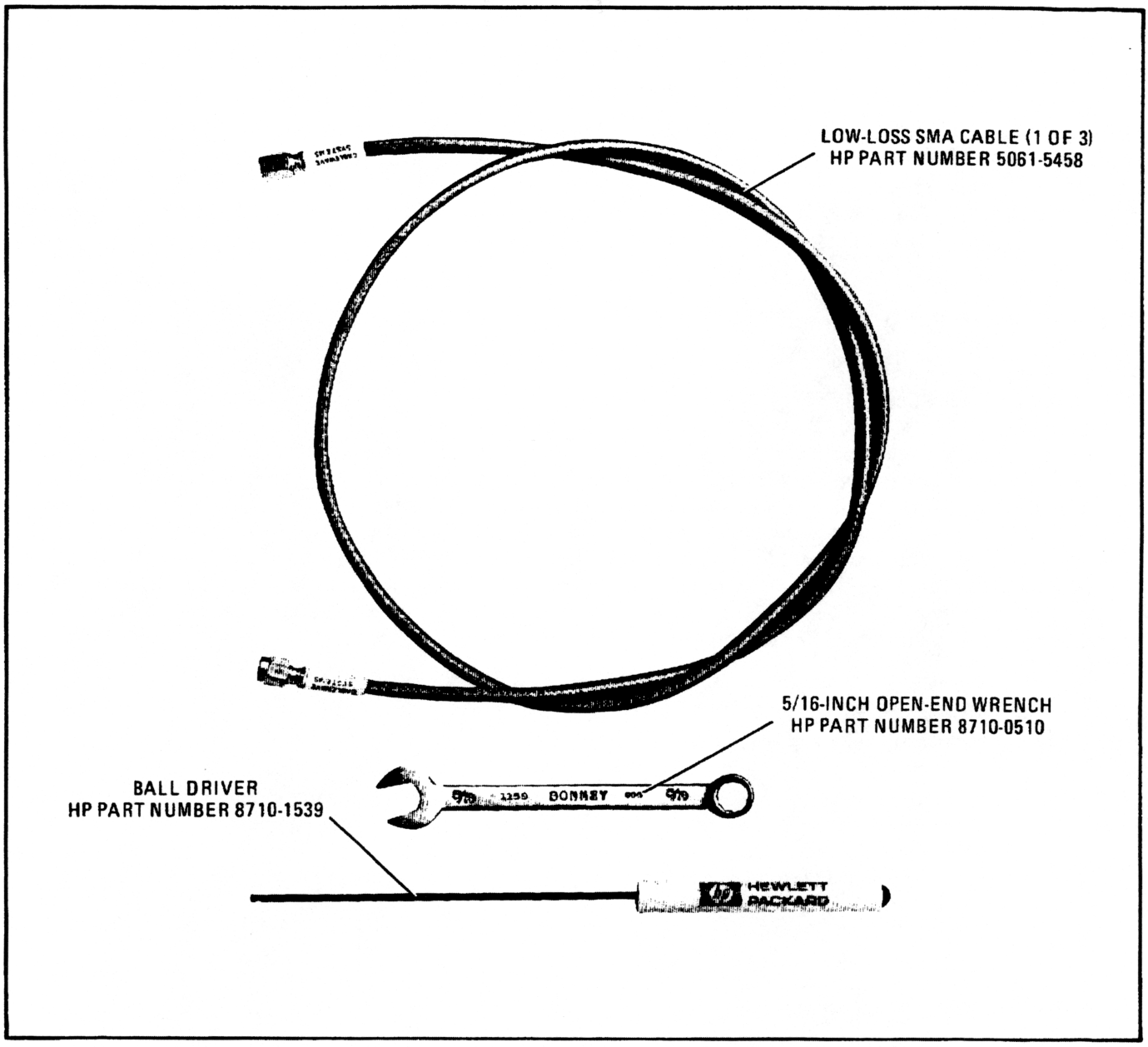


Figure 1-2. Mixer Connection Kit, Option 009

Change 1 replaces existing Memory Board Assembly A14 with a newer Memory Board Assembly, HP Part Number 85660-60181. Change 2 requires External Mixer Modification Kit, HP Part Number 85660-60143. In this change, the 321.4 MHz IF is rerouted to the front panel, and Miscellaneous Bias/Relay Driver Board Assembly A6A10 and Slope Generator Board Assembly A6A11 are replaced with newer board assemblies. Installation of the External Mixer Modification Kit is described in HP Service Note 8566A-6.

SPECIFICATIONS

Specifications for the HP Model 11970 Series Mixers are listed in Table 1-1. These are the performance standards against which the mixers are tested (performance tests are provided in Section III). Typical or nominal operating values are listed in Table 1-2, Supplemental Characteristics. Supplemental characteristics are included only as additional information; they are not specifications.

EQUIPMENT SUPPLIED

Waveguide Connector Screws

Five hex-head screws are supplied with each mixer. Four are required to make the mixer-to-waveguide connection, one is a spare. Use **ONLY** the screws supplied with it to attach the mixer to the waveguide. Because of slight differences in the way the mixers couple with the waveguide, the square-flange mixers (Models 11970K and 11970A) and the round-flange mixer (Model 11970Q, 11970U, 11970V and 11970W) require different screws. If your mixer has a square waveguide flange, use four hex-head screws with HP Part Number 3030-0221. If it has a round waveguide flange, use four hex-head captive screws with HP Part Number 1390-0671. The special ball-driver hex screwdriver available in the Option 009 Mixer Connector Kit simplifies installation of the waveguide connector screws.

TEST EQUIPMENT AND ACCESSORIES AVAILABLE

Equipment and accessories recommended for testing the Model 11970 Series Mixers are listed in Section III.

The 11969A is a wooden, internally padded, transportation and storage case (HP Part Number 5061-5459). This case will hold as many as five different mixers. (See Figure 1-3).

ENVIRONMENTAL LIMITATIONS

The HP 11970 Series Mixers meet or exceed the environmental requirements of MIL-T-28800C, Type III, Class 3, Style C. Specific environmental qualifications for the mixers are as follows:

Temperature, Non-operating: -40°C to +75°C
Temperature, Operating: 0°C to +55°C
Relative Humidity: 95 ±5% up to 30°C
Altitude, Non-operating: Less than 12,195 meters (40,000 ft.)
Altitude, Operating: Less than 3,048 meters (10,000 ft.)
Maximum Vibration Levels: 2 G's at 5 to 2000 Hz
Maximum Shock: 30 G's

Table 1-1. HP 11970 Series Specifications (1 of 2)

NOTE

Unless otherwise stated, all specifications apply for an IF of 321.4 MHz and for RF input amplitudes of less than −20 dBm.

GENERAL

LO Amplitude Range:
+14 to +18 dBm[1]

Calibration Accuracy:
11970K/A/Q/U:
±2.0 dB with LO amplitude range of 14.5 to 16 dBm
11970V/W:
±2.2 dB with LO amplitude range of 14.5 to 16 dBm
11970K/A/Q/U:
±3.0 dB with LO amplitude range of 16 to 18 dBm
11970V/W:
±3.2 dB with LO amplitude range of 16 to 18 dBm

Bias Requirements:
None

Maximum CW RF Input Level:
+20 dBm (100 mW)

Maximum Peak Pulse Power:
+24 dBm with <1 μsec pulse (avg. power: +20 dBm)

Environmental:
Meets MIL-T-28800C, Type III, Class 3, Style C

IF/LO Connectors:
SMA female (replaceable)

MODEL 11970K

RF Frequency Range:
18 – 26.5 GHz

LO Harmonic Number: 6

LO Input Frequency Range:
2.95 – 4.36 GHz

Maximum Conversion Loss: 24 dB

HP 8566B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
−110 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
±1.9 dB

Frequency Response at +14 to +18 dBm LO Input Power:
±2.8 dB

MODEL 11970A

RF Frequency Range:
26.5 – 40 GHz

LO Harmonic Number: 8

LO Input Frequency Range:
3.27 – 4.96 GHz

Maximum Conversion Loss: 26 dB

HP 8566B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
−108 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
±1.9 dB

Frequency Response at +14 to +18 dBm LO Input Power:
±2.8 dB

[1]The HP 11975A Amplifier, or a similar amplifier, must be used to provide sufficient LO power (14 to 18 dBm) to the mixers. Leveled power capability of +16 dBm, as is available with the HP 11975A, is necessary to achieve the maximum amplitude accuracy with the mixers.

Table 1-1. HP 11970 Series Specifications (2 of 2)

MODEL 11970Q

RF Frequency Range:
33 – 50 GHz

LO Harmonic Number: 10

LO Input Frequency Range:
3.27 – 4.97 GHz

Maximum Conversion Loss: 28 dB

HP 8566B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
– 104 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
± 1.9 dB

Frequency Response at +14 to +18 dBm LO Input Power:
± 2.8 dB

MODEL 11970U

RF Frequency Range:
40 – 60 GHz

LO Harmonic Number: 10

LO Input Frequency Range:
3.97 – 5.97 GHz

Maximum Conversion Loss: 28 dB

HP 8566B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
– 104 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
± 1.9 dB

Frequency Response at +14 to +18 dBm LO Input Power:
± 2.8 dB

MODEL 11970V

RF Frequency Range:
50 – 75 GHz

LO Harmonic Number: 14

LO Input Frequency Range:
3.55 – 5.33 GHz

Maximum Conversion Loss: 40 dB

HP 8566B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
– 92 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
± 2.1 dB

Frequency Response at +14 to +18 dBm LO Input Power:
± 2.8 dB

MODEL 11970W

RF Frequency Range:
75 – 110 GHz

LO Harmonic Number: 18

LO Input Frequency Range:
4.15 – 6.09 GHz

Maximum Conversion Loss: 46 dB

HP 8566B Noise Level at 1 kHz Bandwidth, and +14.5 to +16 dBm LO Input Power:
– 85 dBm

Frequency Response at +14.5 to +16 dBm LO Input Power:
± 3.0 dB[1]

Frequency Response at +14 to +18 dBm LO Input Power:
± 4.0 dB

[1]Typically ± 2.5 dB with LO supplied by 8566B Spectrum Analyzer, 11975A Amplifier set to + 16 dBm, and HP P/N 5061-5458 SMA cables.

Table 1-2. HP 11970 Supplemental Characteristics

NOTE

Supplemental characteristics are included only as additional information; they are not specifications.

3 dB IF Bandwidth: DC to 1.3 GHz

Spectrum Analyzer Absolute Amplitude Accuracy (using calibration data with a +14.5 to +16 dBm LO):
11970K, 18 – 26.5 GHz: ±3.2 dB
11970A, 26.5 – 40 GHz: ±3.2 dB
11970Q, 33 – 50 GHz: ±3.2 dB
11970U, 40 – 60 GHz: ±3.2 dB
11970V, 50 – 75 GHz: ±3.4 dB
11970W, 75 – 110 GHz: ±3.4 dB

RF Input SWR:
11970K/A/Q/U: <2.2:1
11970V/W: <2.6:1

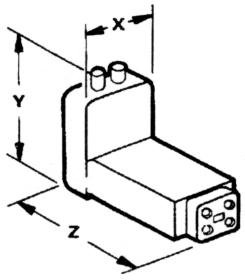
Odd Order Mixing Product Suppression:
11970K/A/Q/U: >20 dB
11970V/W: >15 dB

Gain Compression Level (<1 dB):
11970K: −3 dBm
11970A: −5 dBm
11970Q: −7 dBm
11970U: −7 dBm
11970V: −3 dBm
11970W: −1 dBm

5061-5458 Cable Insertion Loss:
.8 dB at 2 GHz
1.1 dB at 6 GHz

PHYSICAL CHARACTERISTICS

Model	Flange[1]	Weight	X	Y	Z
11970K	UG-595/U WR-42	0.17 kg 0.36 lb	36 mm 1.4 in	51 mm 2.0 in	90 mm 3.5 in
11970A	UG-599/U WR-28	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	71 mm 2.8 in
11970Q	UG-383/U WR-22	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in
11970U	UG-383/U-M WR-19	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in
11970V	UG-385/U WR-12	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in
11970W	UG-385/U-M WR-10	0.14 kg 0.32 lb	36 mm 1.4 in	51 mm 2.0 in	76 mm 3.0 in



[1]Waveguide attachment screws enter blind holes in the flanges of the mixers.

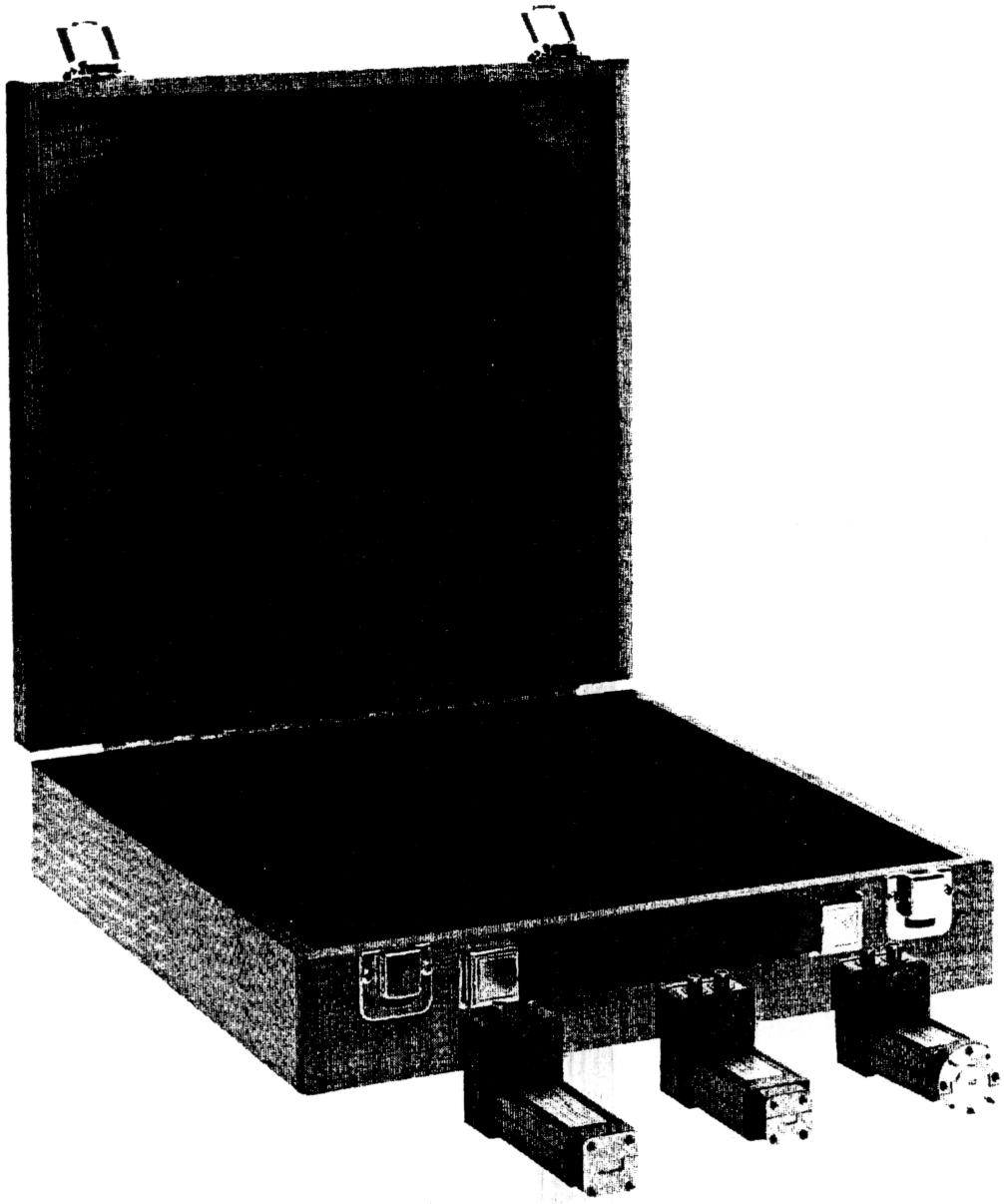


Figure 1-3. HP 11969A Transportation and Storage Case

SECTION II OPERATION

INTRODUCTION

This section provides information on how to make effective use of the HP 11970 mixers.

OPERATING PRECAUTIONS

Do not exceed the maximum ratings listed below or permanent damage to the mixer will result.

RF Input Power

CW: No greater than +20 dBm
Pulse: No greater than +24 dBm at $\leq$ 1 µSec
Average: No greater than +20 dBm

LO Input Power

No greater than +20 dBm

Electrostatic Discharge

When installing the mixer, you must always connect the SMA cables to the spectrum analyzer and LO amplifier **BEFORE** connecting them to the mixer. This will minimize the danger of an electrostatic discharge damaging the mixer diodes.

HP 11975A ALC Switch

BEFORE using the HP 11975A Amplifier to increase the LO input power, set the amplifier ALC switch to the ON position. When this switch is in the OFF position the LO power can be greater than +20 dBm. This level of LO power can destroy the mixer diodes. The ALC switch is on the amplifier rear panel.

Waveguide Protective Foam

Do not remove, displace, or damage the white, non-conductive foam installed in the open end of the waveguide. Since the mixer is amplitude calibrated with this foam in place, tampering with it affects the calibration.

GETTING STARTED

NOTE

See Section I for information relating to retrofit requirements for older Model 8566A Spectrum Analyzers.

The HP 11970 series of millimeter wave mixers have no bias or back-short adjustments.

HP 11970 Mixers require an LO power of +14 to +18 dBm at the LO input. If the spectrum analyzer used with the HP 11970 does not have sufficient LO power, an HP 11975A Amplifier or an equivalent is required to increase this power.

CAUTION

Before connecting the HP 11975A Amplifier, set its rear panel ALC switch to ON. Failure to do this can damage the mixer.

With the three SMA cables (HP Part Number 5061-5458, each) provided in the Option 009 Mixer Connection Kit, connect the HP 11970 Mixer, the spectrum analyzer, and the HP 11975A Amplifier as shown in Figure 2-1.

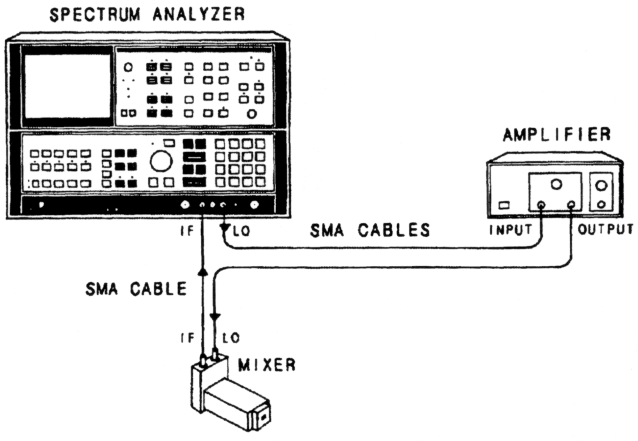


Figure 2-1. HP 11970 Mixer Connections

Leave the waveguide flange cap on whenever the mixer is not connected to a device under test. This protects the flange mating surface from scratches, which can degrade the mixer's performance. Use an appropriate waveguide attenuator if the output power of the unit under test exceeds the RF Input Power indicated in the specifications.

If you are using an HP 11970Q, 11970U, 11970V or 11970W Mixer, and the shoulder of its waveguide flange is not properly aligned with the flange of the device under test, amplitude measurement errors can result. To ensure proper alignment, tighten each of the four flange screws in turn by small amounts, moving clockwise around the flange.

NOTE

HP 11970K and 11970A Mixers require flange screws that are different from those used with the HP 11970Q, 11970U, 11970V and 11970W; HP 11970K and 11970A use HP Part Number 3030-0221 (#4-40 hex head screw). HP 11970Q, 11970U, 11970V and 11970W use HP Part Number 1390-0671 (#4-40 hex head captive screw).

MEASUREMENTS WITH HP 11970 MIXERS

The control settings used in this section are for the HP 8566A/B Spectrum Analyzer because: first, the HP 8566A/B IF input requires a 321.4 MHz signal, and this is compatible with the IF calibration frequency of the HP 11970 Mixer. This output, specifically designed for a 321.4 MHz IF, is coupled through a 1.5 GHz low-pass filter. Second, the frequency range of the HP 8566A/B's 1st LO output is between 3 and 6 GHz, which fullfills the LO input frequency requirements of the HP 11970.

BASIC FREQUENCY MEASUREMENTS

Press **[SHIFT]** **[↑]** **(KSU)**. This sets the HP 8566A/B to the external mixing mode. It also sets the RF attenuator to 10 dB. When you use an external mixer, the attenuator must remain at this value to maintain the correct reference level. Except for the attenuator and reference level, operating the HP 8566A/B in the external mixing mode is identical with the standard operation described in the HP 8566A/B Operation Manual.

If the frequency of the signal to be analyzed is known, tune to this frequency using the **[CENTER FREQUENCY]** button. To see the signal with more detail, reduce the frequency span with the **[FREQUENCY SPAN]** button. If the frequency of the signal is not known, use the signal identification procedure below.

IDENTIFYING SIGNALS WITH THE HP 8566A/B

Press **[SHIFT]** **[↑]** **(KSU)**. This sets the HP 8566A/B in the external mixing mode. In this mode, most of the signals on the screen do not represent signals present at the input of the mixer. They are responses of the input signal(s) mixing with several harmonics of the LO.

Notice that the START frequency is set at 18.6 GHz and the STOP frequency at 26.5 GHz. Press **[START FREQ]**. Enter, using the DATA keys, the frequency that is the lower end of the HP 11970's frequency range. Press **[STOP FREQ]**. Enter the upper end of the HP 11970's range.

Press MARKER MODE **[NORMAL]**. Tune the marker to the response to be identified using the DATA knob. Press **[SHIFT] [FREE RUN] (KSv)**. This activates the HP 8566A/B's microprocessor based signal identification routine. If positive identification is made, the display will be the same as shown in Figure 2-2. The span will be 200 MHz with the Center Frequency set to the signal frequency. Press **[7]** to reconfirm the identificaion. If the same signal is found again, it is a signal that is present at the input of the HP 11970 mixer.

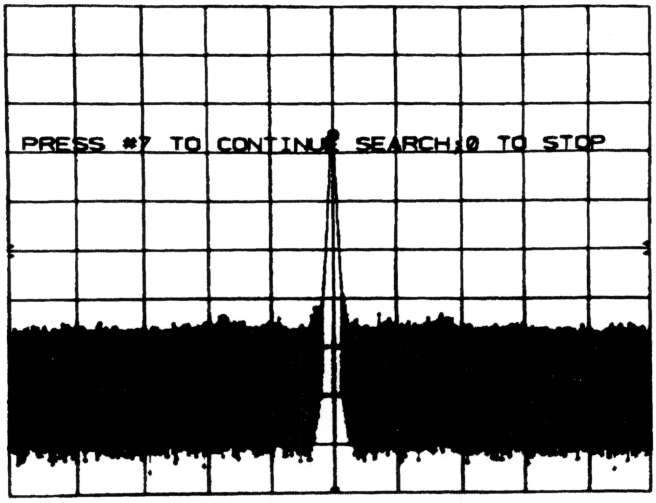


Figure 2-2. Positive Signal Identification

If positive identification is NOT made by the signal identification routine, the HP 8566A/B will return the display that was present before **[SHIFT] [FREE RUN] (KSv)** was pressed, with the message RECALL: REG 7.

Signals with residual FM, or FM or pulse modulation might not be successfully identified with the Signal Identification routine. If in doubt, use the "image frequency method" instead as follows: Set **[FREQUENCY SPAN]** to **[1] [GHz]**. Press **[CENTER FREQUENCY]** and rotate the DATA knob to display a possible true signal and its image pair. A signal is identified if it is the left (or lower) frequency component of an image pair separated by 642 MHz (twice the 321.4 MHz IF). Refer to Figure 2-3 for a correctly identified 10+ response and for the unwanted 12th harmonic response.

AMPLITUDE CALIBRATED MEASUREMENTS

The HP 8566A/B Spectrum Analyzer can make amplitude calibrated measurements of millimeter signals with the HP 11970 mixers. A calibration table like the one shown in Figure 2-4 is provided with each HP 11970 Mixer. A smaller version of the graph shown on the table is on the mixer itself. The table shows conversion loss and reference level offset as a function of frequency.

In the external mixing mode, the HP 8566A/B gain is automatically increased 30 dB to compensate for the conversion loss of an external mixer. Using the information in the calibration table supplied with the

HP 11970 Mixer, you can offset the reference level to obtain a precise amplitude calibration. For example, if the calibration table indicates the Reference Level Offset for a frequency of 45.0 GHz is -6.8 dB, this offset would be entered by pressing: **[SHIFT] [REF LEVEL] [6] [.] [8] [MHz/-dBm/sec].**

With the offset entered, the HP 8566A/B is amplitude calibrated at 45.0 GHz. The reference level offset is determined by the following equation:

Conversion Loss - 30 dB = Reference Level Offset

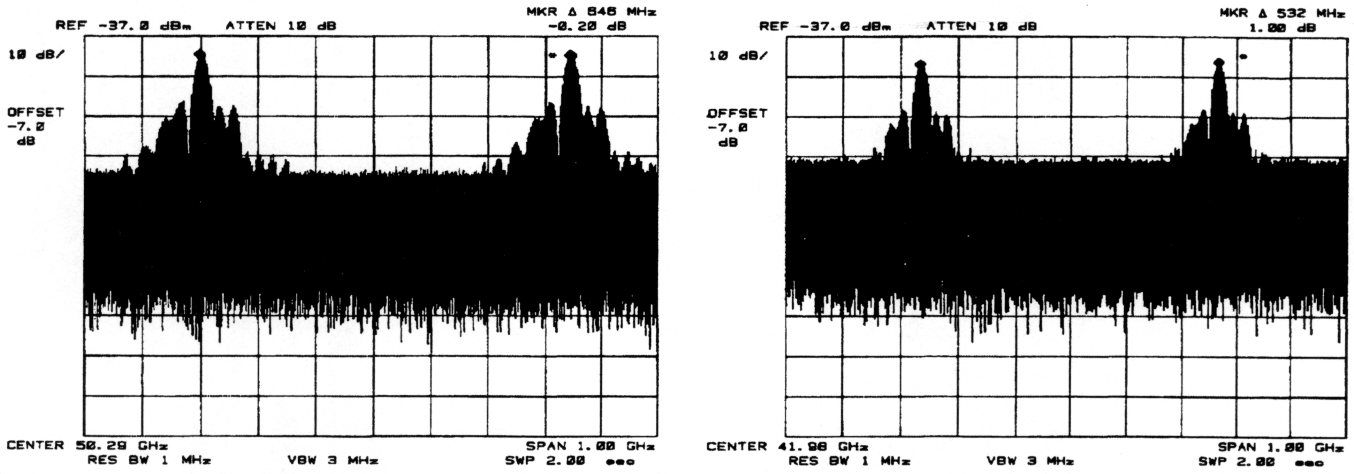


Figure 2-3. Correctly Identified 10th Harmonic Response (left), and Unwanted 12th Harmonic Response (right)

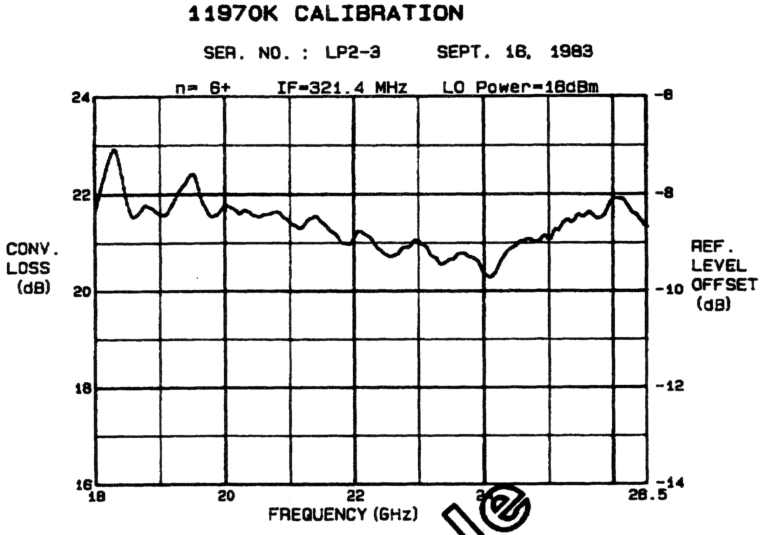
NOTE

For the REFERENCE LEVEL to function properly, the ATTEN (attenuator) must remain at 10 dB.

If you are using an HP 11970K, 11970Q, 11970U, 11970V or 11970W, amplitude measurements taken after signal identification can be erroneous. This error occurs when signal identification returns the signal with other than the specified harmonic at the ends of the mixers' frequency range. Refer to Table 2-1 for the specific frequencies and harmonics involved. Since each harmonic of the LO has a different power level, conversion loss and amplitude vary accordingly. Verification of the harmonic number being used is possible by accessing the Frequency Diagnostic Function. To do this press **[SHIFT][MKR→REF LEVEL](KSR)**. The first number in line 3 is the mixing harmonic number. To remove this display, press **[2-22GHz]** and then **[RECALL][7]**. To restore calibration at the frequencies indicated in Table 2-1, tune to the center of the mixer's frequency range and press **[SHIFT] [CONT] (KSt)**. Next, tune to the signal you wish to measure and make your amplitude measurement.

NOTE

The HP 11970A exhibits the amplitude problem mentioned above only when amplitude measurements are attempted outside its specified frequency range.



Sample

FREQ.	CONV. LOSS	REF. LVL OFS.	FREQ.	CONV. LOSS	REF. LVL OFS.
18.00	21.7	-8.3	22.25	21.1	-8.9
18.25	22.8	-7.2	22.50	20.7	-9.3
18.50	21.7	-8.3	22.75	20.9	-9.1
18.75	21.8	-8.2	23.00	21.0	-9.0
19.00	21.8	-8.4	23.25	20.7	-9.3
19.25	22.0	-8.0	23.50	20.7	-9.3
19.50	22.4	-7.6	23.75	20.7	-9.3
19.75	21.8	-8.4	24.00	20.4	-9.6
20.00	21.8	-8.2	24.25	20.6	-9.4
20.25	21.8	-8.4	24.50	21.0	-9.0
20.50	21.5	-8.5	24.75	21.0	-9.0
20.75	21.8	-8.4	25.00	21.1	-8.9
21.00	21.4	-8.8	25.25	21.5	-8.5
21.25	21.4	-8.6	25.50	21.5	-8.5
21.50	21.4	-8.8	25.75	21.5	-8.5
21.75	21.1	-8.9	26.00	21.9	-8.1
22.00	21.1	-8.9	26.25	21.7	-8.3
			26.50	21.3	-8.7

Figure 2-4. Sample Mixer Calibration Table

Table 2-1. Amplitude Cal Status After Signal ID

HP 11970K MIXER 18.0 to 26.5 GHz/6 + harmonic			HP 11970A MIXER 26.5 to 40 GHz/8 + harmonic			HP 11970Q MIXER 33 to 50 GHz/10 + harmonic		
Input Signal Identified	Harmonic Used After Signal Identification	Amplitude Calibrated After Signal Identification?	Input Signal Identified	Harmonic Used After Signal Identification	Amplitude Calibrated After Signal Identification?	Input Signal Identified	Harmonic Used After Signal Identification	Amplitude Calibrated After Signal Identification?
18.0 – 18.6 GHz	4 +	NO	26.5 – 40 GHz	8 +	YES	33.0 – 40.2 GHz	8 +	NO
18.6 – 26.3 GHz	6 +	YES				40.2 – 50.0 GHz	10 +	YES
26.3 – 26.5 GHz	8 +	NO						

HP 11970U MIXER 40 to 60 GHz/10 + harmonic			HP 11970V MIXER 50 to 75 GHz/14 + harmonic			HP 11970W MIXER 75 to 110 GHz/18 + harmonic		
Input Signal Identified	Harmonic Used After Signal Identification	Amplitude Calibrated After Signal Identification?	Input Signal Identified	Harmonic Used After Signal Identification	Amplitude Calibrated After Signal Identification?	Input Signal Identified	Harmonic Used After Signal Identification	Amplitude Calibrated After Signal Identification?
40.0 – 40.2 GHz	8 +	NO	50.0 – 60.1 GHz	10 +	NO	75.0 – 84.1 GHz	14 +	NO
40.0 – 40.2 GHz	10 +	YES	60.1 – 72.1 GHz	12 +	NO	84.1 – 97.7 GHz	16 +	NO
			72.1 – 75.0 GHz	14 +	YES	97.7 – 110 GHz	18 +	YES

SECTION III PERFORMANCE TESTS

INTRODUCTION

This section contains instructions for testing the performance of the HP 11970 Series Mixers. Performance tests are used to check the mixers at incoming inspection and for periodic evaluation. The tests verify the specifications listed for the mixers in Table 1-1.

Test equipment required for the performance tests is listed in Table 3-1 for the HP 11970K, Table 3-2 for the HP 11970A, Table 3-3 for the HP11970Q, Table 3-4 for the HP 11970U, Table 3-5 for the HP 11970V and Table 3-6 for the HP 11970W. Test instruments other than those listed may be used provided their performance equals or exceeds the critical specifications listed in Tables 3-1 through 3-6.

TEST RECORD

At the end of each test is a test record, which is used for recording the performance test data. Make copies of these test records and use them as worksheets when doing the tests.

PERFORMANCE TEST PROCEDURES

Each performance test procedure is contained in a single paragraph. The first entry in each paragraph is the specification for the parameter being measured as described in Table 1-1. This is followed by a general description of the test and any special instructions or problem areas. Appropriate test setup illustrations are included in this section and are referenced in the procedures. You MUST do the tests, and the steps within each test, in the order they are given.

Table 3-1. Recommended Test Equipment For HP 11970K

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8566B
Synthesized Sweeper	Frequency: 18 to 26.5 GHz Output Level: > – 10 dBm	HP 8340A
Amplifier	Output Level: >18 dBm leveled Frequency Range: 3 to 4.5 GHz	HP 11975A
Power Meter	Compatible with Power Sensor	HP 436A
Power Sensor	SWR: <1.3	HP 8485A
Directional Coupler*	Coupling: 10 dB Directivity: >40 dB Primary Arm SWR: <1.05 Auxiliary Arm SWR: <1.2	HP K752C
Isolator	Insertion Loss: <1.5 dB Isolation: >20 dB SWR: <1.2	HP P/N 0960-0081
Adapter (2 required)	3.5 mm female to WR-42 SWR: <1.1	HP K281C
Cables (3 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396

*Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

Table 3-2. Recommended Test Equipment For HP 11970A

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8566B
Synthesized Sweeper	Frequency: 8 to 13.5 GHz Output Level: >0 dBm	HP 8340A
Amplifier	Output Level: > + 18 dBm leveled Frequency Range: 3 to 5 GHz	HP 11975A
Amplifier	Frequency Range: 8 to 13.5 GHz Output Level: > + 15 dBm	HP 8349A
Power Meter	Compatible with Power Sensor	HP 436A
Power Sensor	SWR: <2.0	HP R8486A
Power Sensor	SWR: <1.3 @ 6 GHz	HP 8485A
Directional Coupler[1]	Coupling: 20 dB Directivity: >40 dB Primary Arm SWR: <1.05 Auxiliary Arm SWR: <1.2	HP R752D
Isolator	Insertion Loss: <1.5 dB Isolation: >20 dB SWR: <1.2	HP P/N 0960-0082
Frequency Tripler	Input Power: > + 10 dBm minimum Conversion Loss: <15 dB	Spacekom Microwave[2] TKa-1
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter	SMA female to Type N female	HP P/N 1250-1404
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Cables (3 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396
Cable	Connectors: BNC male	HP 11086A

[1]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

[2]Honeywell, Inc. Spacekom Microwave Center, Santa Barbara, CA

Table 3-3. Recommended Test Equipment For HP 11970Q

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8566B
Synthesized Sweeper	Frequency: 11.0 to 16.7 GHz Output Level: >0 dBm	HP 8340A
Amplifier	Output Level: > + 18 dBm leveled Frequency Range: 4 to 6 GHz	HP 11975A
Amplifier	Frequency Range: 11.0 to 16.7 GHz Output Level: > + 15 dBm	HP 8349A
Power Meter	Compatible with Power Sensor	HP 436A
Power Sensor	SWR: <2.0	HP Q8486A
Power Sensor	SWR: <1.3 @ 6 GHz	HP 8485A
Directional Coupler[1]	Coupling: 20 dB Directivity: >30 dB Auxiliary Arm SWR: <1.2	HP Q752D
Isolator	Insertion Loss: <2 dB Isolation: >20 dB SWR: <1.5	HP U365A
Frequency Tripler	Conversion Loss: <20 dB	Spacekom Microwave[2] TB-1
Adapter	SMA female to Type N female	HP P/N 1250-1404
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396
Cable	Connectors: BNC male	HP 11086A

[1]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

[2]Honeywell, Inc. Spacekom Microwave Center, Santa Barbara, CA

Table 3-4. Recommended Test Equipment For HP 11970U

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8566B
Synthesized Sweeper	Frequency: 13.3 to 20.0 GHz Output Level: >+9 dBm	HP 8340A
Amplifier	Output Level: >+18 dBm leveled Frequency Range: 4 to 6 GHz	HP 11975A
Amplifier	Frequency Range: 13.3 to 20.0 GHz Output Level: >+15 dBm	HP 8349A
Power Meter	Compatible with Power Sensor	HP 432A
Power Sensor	SWR: <2.0	Hughes[1] 45773H-1100
Power Sensor	SWR: <1.3 @ 6 GHz	HP 478A
Directional Coupler[2]	Coupling: 20 dB Directivity: >30 dB Auxiliary Arm SWR: <1.2	HP U752D
Isolator	Insertion Loss: <2 dB Isolation: >20 dB SWR: <1.5	HP U365A
Frequency Tripler	Conversion Loss: <20 dB	Spacekom Microwave[3] TQ-1
Adapter	SMA female to Type N female	HP P/N 1250-1404
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396
Cable	Connectors: BNC male	HP 11086A

[1]Hughes Aircraft Co. Electron Dynamics Division, Torrance, CA

[2]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

[3]Honeywell, Inc. Spacekom Microwave Center, Santa Barbara, CA

Table 3-5. Recommended Test Equipment For HP 11970V

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8566B
Swept Source	Compatible with V-Band Plug-In	HP 8350B
V-Band Source Plug-In	Frequency Range: 50 to 75 GHz Output Level: >0 dBm	Hughes[1] 47724H-1510
Amplifier	Output Level: >+18 dBm leveled Frequency Range: 4 to 6 GHz	HP 11975A
Power Meter	Compatible with Power Sensor	HP 432A
Power Sensor	SWR: <2.0	Hughes[1] 45774H-1100
Power Sensor	SWR: <1.3 @ 6 GHz	HP 478A
Directional Coupler[2]	Coupling: 20 dB Directivity: >20 dB Auxiliary Arm SWR: <1.5	Hughes [1] 45324H-1220
Variable Attenuator	Range: 0 to 15 dB	TRG[3] 510V/385
Adapter	SMA female to Type N female	HP P/N 1250-1404
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396
Cable	Connectors: BNC male	HP 11086A

[1]Hughes Aircraft Co. Electron Dynamics Division, Torrance, CA

[2]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

[3]Alpha Industries Inc. TRG Division, Woburn, MA

Table 3-6. Recommended Test Equipment For HP 11970W

Instrument	Critical Specifications	Recommended Model
Spectrum Analyzer	LO and IF ranges compatible with mixer	HP 8566B
Swept Source	Compatible with W-Band Plug-In	HP 8350B
W-Band Source Plug-In	Frequency Range: 75 to 110 GHz Output Level: >0 dBm	Hughes[1] 47726H-1510
Amplifier	Output Level: > + 18 dBm leveled Frequency Range: 4 to 6 GHz	HP 11975A
Power Meter	Compatible with Power Sensor	HP 432A
Power Sensor	SWR: <2.0	Hughes[1] 45776H-1100
Power Sensor	SWR: <1.3 @ 6 GHz	HP 478A
Directional Coupler[2]	Coupling: 20 dB Directivity: >20 dB Auxiliary Arm SWR: <1.5	Hughes [1] 45326H-1220
Variable Attenuator	Range: 0 to 15 dB	TRG[3] W510
Adapter	SMA female to Type N female	HP P/N 1250-1404
Adapter	SMA female to SMA female	HP P/N 1250-1158
Adapter (2 required)	Type N male to SMA female	HP P/N 1250-1250
Cables (4 required)	Connectors: SMA male	HP P/N 5061-5458
Cable	Connectors: SMA male Loss: <1.0 dB @ 20 GHz	HP P/N 8120-4396
Cable	Connectors: BNC male	HP 11086A

[1]Hughes Aircraft Co. Electron Dynamics Division, Torrance, CA

[2]Calibration data for the coupling ratio between the output arm and the auxiliary arm is necessary for accurate measurements.

[3]Alpha Industries Inc. TRG Division, Woburn, MA

CONVERSION LOSS AND FREQUENCY RESPONSE

Specifications

Conversion Loss:

For a CW RF input power of less than -20 dBm

HP 11970K: 24 dB maximum
HP 11970A: 26 dB maximum
HP 11970Q: 28 dB maximum
HP 11970U: 28 dB maximum
HP 11970V: 40 dB maximum
HP 11970W: 46 dB maximum

Frequency Response:

For an LO amplitude between +14.5 and +16.0 dBm

HP 11970K: ±1.9 dB
HP 11970A: ±1.9 dB
HP 11970Q: ±1.9 dB
HP 11970U: ±1.9 dB
HP 11970V: ±2.1 dB
HP 11970W: ±3.0 dB

For an LO amplitude between +14.0 and +18.0 dBm

HP 11970K: ±2.8 dB
HP 11970A: ±2.8 dB
HP 11970Q: ±2.8 dB
HP 11970U: ±2.8 dB
HP 11970V: ±2.8 dB
HP 11970W: ±4.0 dB

Description

The frequency response and conversion loss are checked at four LO power levels. A known input power is applied to the input of the mixer. The IF output power is measured on the HP 8566A/B Spectrum Analyzer. From these measurements, the conversion loss and frequency response are calculated.

1. Connect an SMA cable from the 1st LO OUTPUT of the spectrum analyzer to the INPUT of the amplifier. Connect a second SMA cable to the OUTPUT of the amplifier.

2. For HP 11970K: Zero and calibrate the power meter. For HP 11970A, 11970Q, 11970U, 11970V or 11970W: Connect the HP 478A Power Sensor to the power meter sensor cables, then zero the power meter.

3. Set the HP 8566A/B Spectrum Analyzer controls as follows:

   [SHIFT] [↑] (KSU)
   [FREQUENCY SPAN] [0] [Hz]

[SHIFT] SWEEP [CONT] (KSt)
[CENTER] [2] [4] [.] [5] [GHz]

CAUTION

When you are using an HP 11975A Amplifier with an HP 11970 Series Mixer, you MUST set the amplifier rear-panel ALC switch to ON before you connect the amplifier into the test setup. If the ALC switch is left in the OFF position, the amplifier output power is high enough to destroy the mixer diodes.

4. On the HP 11975A Amplifier, set the rear panel ALC switch to ON, then connect the power sensor to the free end of the cable installed on the OUTPUT connector of the amplifier. Set the power meter Cal Factor to the appropriate value for a frequency of 4 GHz.

5. Adjust the amplifier OUTPUT POWER LEVEL for a reading of +14.0 ±0.1 dBm on the power meter. Record the LO power in Table 3-7.

6. Set the power meter Cal Factor to 100 percent.

7. Connect the equipment as shown in Figure 3-1.

CAUTION

Make sure the HP 8349A Amplifier, used in the signal generator system for HP 11970A, Q and U tests, is set for external leveling before you turn it on. Failure to set this amplifier for external leveling may allow the amplifier output to rise about +20 dBm, which is high enough to damage the frequency tripler.

8. Set the signal generator for a CW output signal at the frequencies listed below:

   HP 11970K: 18.0 GHz
   HP 11970A: 26.5 GHz
   HP 11970Q: 33.0 GHz
   HP 11970U: 40.0 GHz
   HP 11970V: 50.0 GHz
   HP 11970W: 75.0 GHz

9. Adjust the output power of the signal generator for a reading of approximately -10 dBm on the power meter for the HP 11970K, V or W and for approximately -3 dBm for the HP 11970A, Q or U. (Make sure that the unleveled light is not on for the 11970V and 11970W. Vary the power by adjusting the rotary vane attenuator.)

10. On the spectrum analyzer, press **[SHIFT]** and **[MKR/Δ→ STP SIZE]**.

11. Set spectrum analyzer **[CENTER FREQUENCY]** to:

    HP 11970K: 22 **[GHz]**
    HP 11970A: 33 **[GHz]**
    HP 11970Q: 41 **[GHz]**
    HP 11970U: 50 **[GHz]**
    HP 11970V: 62 **[GHz]**
    HP 11970W: 92 **[GHz]**

12. On the spectrum analyzer, press **[SHIFT]** and SWEEP **[CONT]**.

13. Set the spectrum analyzer controls as follows:

    For HP 11970K, A, Q or U:
    [SHIFT] [REFERENCE LEVEL] [3] [0] [dB]
    SCALE **[ENTER dB/DIV] [2] [dB]**
    [RES BW] [1] [MHz]
    [FREQUENCY SPAN] [2] [0] [MHz]
    [CF STEP SIZE] [5] [0] [0] [MHz]

    For HP 11970V or W:
    [SHIFT] [REFERENCE LEVEL] [3] [0] [dB]
    SCALE **[ENTER dB/DIV] [2] [dB]**
    [RES BW] [3] [MHz]
    [FREQUENCY SPAN] [2] [0] [0] [MHz]
    [CF STEP SIZE] [1] [GHz]

    Then press **[REFERENCE LEVEL]**:
    HP 11970K: **[3] [6] [-dBm]**
    HP 11970A: **[3] [8] [-dBm]**
    HP 11970Q: **[4] [0] [-dBm]**
    HP 11970U: **[4] [0] [-dBm]**
    HP 11970V: **[4] [8] [-dBm]**
    HP 11970W: **[5] [6] [-dBm]**

    and **[CENTER FREQUENCY]**:
    HP 11970K: **[1] [8] [GHz]**
    HP 11970A: **[2] [6] [.] [5] [GHz]**
    HP 11970Q: **[3] [3] [GHz]**
    HP 11970U: **[4] [0] [GHz]**
    HP 11970V: **[5] [0] [GHz]**
    HP 11970W: **[7] [5] [GHz]**

14. Press MARKER **[PEAK SEARCH]**. If necessary, press **[MKR→CF]** and use DISPLAY LINE **[ENTER]** to find the average of the signal's peak variations. (When testing HP 11970V or 11970W mixers, it is important to re-zero the power meter for each measurement.)

15. Record the following in Table 3-7.

    Marker Frequency
    Marker Amplitude
    Power Meter Reading

Power Sensor Cal Factor or Correction Factor (dB)
Directional Coupler Coupling Factor

NOTE

For the purposes of this measurement, the directional coupler coupling factor is defined as the ratio of the power at the output flange to the power at the coupled flange.

16. Calculate the conversion loss of the mixer with the following equation:

Conversion Loss = Power Meter Reading - 10 log(Cal Factor) - Spectrum Analyzer Marker Amplitude - Coupling Factor

(or given the Power Meter Correction Factor in dB: Conversion Loss = Power Meter Reading + Power Meter Correction Factor - Spectrum Analyzer Marker Amplitude - Coupling Facter)

For example:
Power Meter Reading = -10.03 dBm
Cal Factor = 94.8%
or Correction Factor = .92 dB
Spectrum Analyzer reading = -39.78 dBm
Coupling Factor = 8.93 dB

then:
Conversion Loss = (-10.03) - 10 log(.948) - (-39.78 dBm) - 8.93 dB = 21.05 dB.

or Conversion Loss = (-10.03 dBm) + .92 dB - (-39.78 dBm) - 8.93 dB = 21.7 dB

Record the conversion loss in Table 3-7.

NOTE

The conversion loss indicated on the mixer calibration label includes the loss in the IF cable. If other than the specified cable is used, then the loss in that cable must be compensated for when making amplitude measurements.

17. Increment the frequency of the signal generator 500 MHz higher.

18. Press DATA [↑], then **[PEAK SEARCH]** and **[MKR→CF]** on the spectrum analyzer.

19. Repeat steps 15 through 18 until the appropriate frequency listed below is reached.

    HP 11970K: 26.5 GHz
    HP 11970A: 40.0 GHz
    HP 11970Q: 50.0 GHz
    HP 11970U: 60.0 GHz
    HP 11970V: 75.0 GHz
    HP 11970W: 110.0 GHz

20. Repeat steps 1 through 19 for LO inputs to the mixer of +14.5 dBm, +16.0 dBm, and +18.0 dBm. In step 5, measure each of these levels at the end of the cable normally connected to the mixer LO input.

21. Frequency response is the difference between the maximum and minimum conversion losses recorded in Table 3-7. For LO power levels between +14.5 and +16.0 dBm this difference must be less than:

    3.8 dB for HP 11970K, 11970A, 11970Q or 11970U
    4.2 dB for HP 11970V
    6.0 dB for HP 11970W

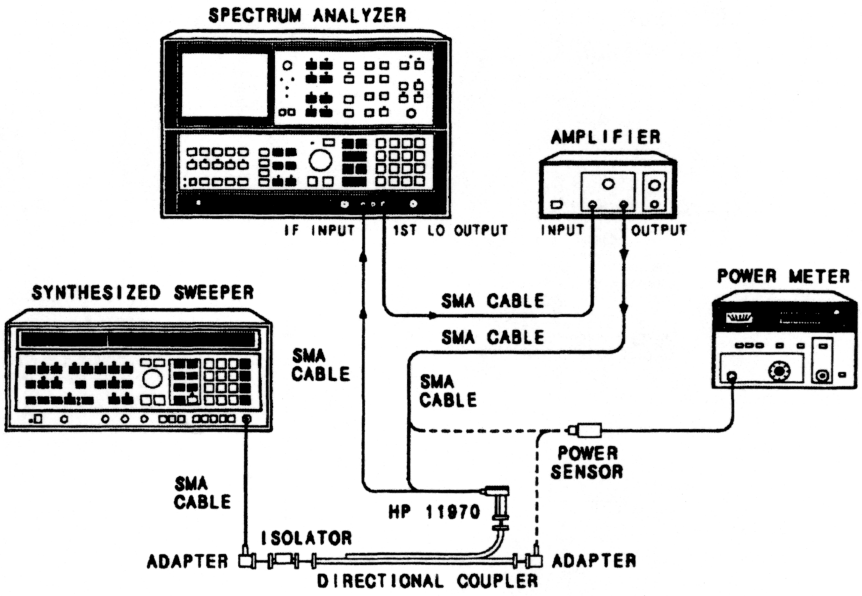
    For LO power levels between +14.0 and +18.0 dBm, the difference must be less than:

    5.6 dB for HP 11970K, 11970A, 11970Q, 11970U or 11970V
    8.0 dB for HP 11970W

22. Maximum conversion loss must not exceed the following limits:

    For an LO input power between +14.0 and +18.0 dBm.
    HP 11970K: 24 dB
    HP 11970A: 26 dB
    HP 11970Q: 28 dB
    HP 11970U: 28 dB
    HP 11970V: 40 dB
    HP 11970W: 46 dB

EQUIPMENT SETUP FOR
THE HP 11970K



EQUIPMENT SETUP FOR
THE HP 11970A, HP 11970Q,
OR HP 11970U

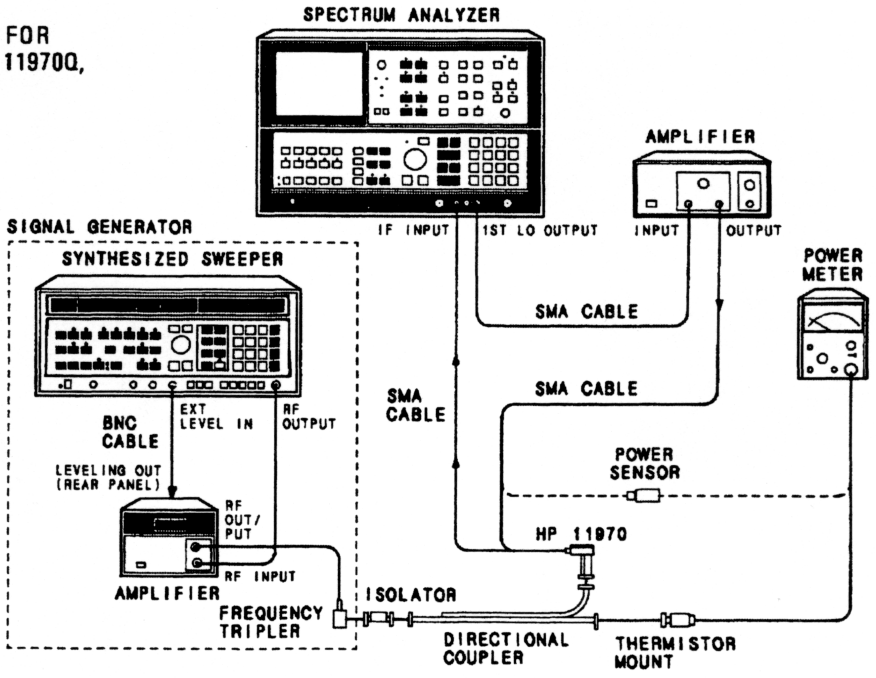


Figure 3-1. Performance Test Setups (1 of 2)

EQUIPMENT SETUP FOR
THE HP 11970V OR HP 11970W

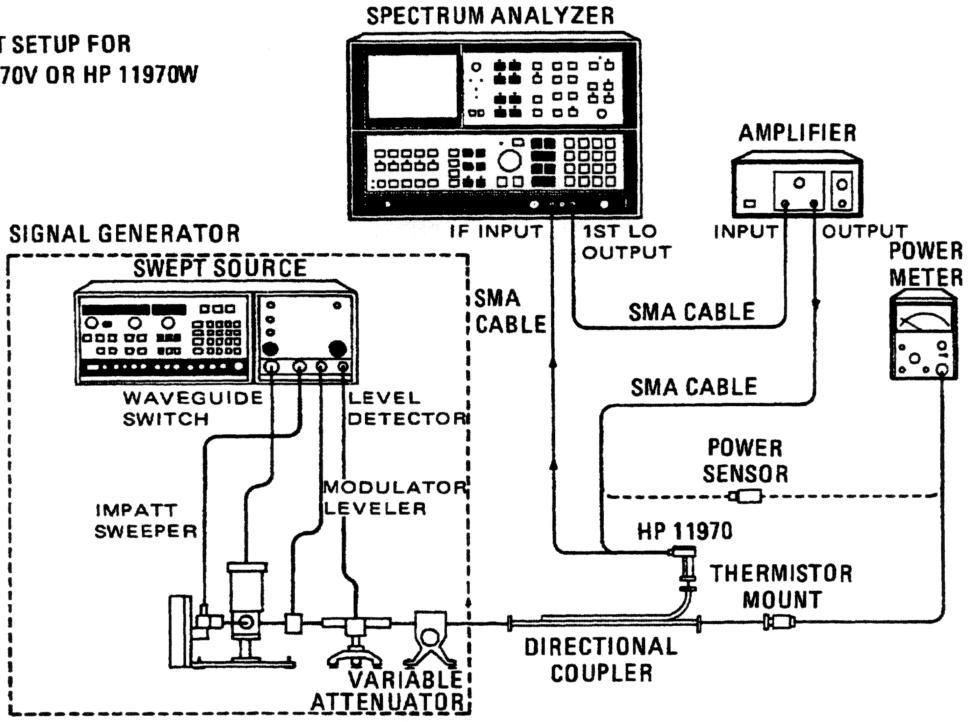


Figure 3-1. Performance Test Setups (2 of 2)

Table 3-7. Conversion Loss and Frequency Response Test Record (1 of 2)

CONVERSION LOSS and FREQUENCY RESPONSE for an LO POWER of _____dBm					
Model Number _____ Serial Number _____			Date _____ Tested by _____		
Marker Frequency	**Marker Amplitude**	**Power Meter Readings**	**Power Sensor Cal Factor**	**Directional Coupler Coupling Factor**	**Conversion Loss**
GHz	**dBm**	**dBm**	**% or dB**	**dB**	**dB**

Table 3-7. Conversion Loss and Frequency Response Test Record (2 of 2)

Marker Frequency	Marker Amplitude	Power Meter Readings	Power Sensor Cal Factor	Directional Coupler Coupling Factor	Conversion Loss
GHz	dBm	dBm	% or dB	dB	dB
Frequency Response = _____dB					

AVERAGE NOISE LEVEL TEST

Specification

HP 11970K: -110 dBm
HP 11970A: -108 dBm
HP 11970Q: -104 dBm
HP 11970U: -104 dBm
HP 11970V: -92 dBm
HP 11970W: -85 dBm

Description

The average displayed noise level in a 1 kHz bandwidth, using external mixing with the HP 8566A/B Spectrum Analyzer, is checked at several LO power levels. This is accomplished by applying a known power to the input of the mixer. The difference between the amplitude of the known signal and the noise floor is measured. From these measurements, the average noise level in a 1 kHz bandwidth is calculated.

1. Connect an SMA cable from the spectrum analyzer LO OUTPUT to the INPUT of the HP 11975A Amplifier. Connect a second SMA cable to the amplifier OUTPUT.

2. For HP 11970K: Zero and calibrate the power meter. For HP 11970A, HP 11970Q, HP 11970U, HP 11970V or HP 11970W: Connect the HP 478A Power Sensor to the power meter sensor cables, then zero the power meter.

3. On the HP 8566A/B Spectrum Analyzer, set the controls as follows:

   [SHIFT] DATA STEP [↑] (KSU)
   [FREQUENCY SPAN] [0] [Hz]
   [SHIFT] SWEEP [CONT] (KSt)
   [CENTER FREQUENCY] [2] [4] [.] [5] [GHz]

CAUTION

When you are using an HP 11975A Amplifier with an HP 11970 Series Mixer, you MUST set the amplifier rear-panel ALC switch to ON before you connect the amplifier into the test setup. If the ALC switch is left in the OFF position, the amplifier output power is high enough to destroy the mixer diodes.

4. On the HP 11975A Amplifier, set the rear panel ALC switch to ON. Then connect the power sensor to the free end of the cable connected to the output of the amplifier. Set the power meter calibration factor to the value shown on the power sensor calibration label for 4 GHz.

5. Adjust the amplifier OUTPUT POWER LEVEL control for a reading of 14.5 ±0.1 dBm on the power meter.

CAUTION

Make sure the HP 8349A Amplifier, used in the signal generator system for HP 11970A, Q and U tests, is set for external leveling before you turn it on. Failure to set this amplifier for external leveling may allow the amplifier output to rise about +20 dBm, which is high enough to damage the frequency tripler.

6. Disconnect the power sensor and connect the equipment as shown in Figure 3-1.

7. On the HP 8566A/B Spectrum Analyzer, set the controls as follows:

   For HP 11970K, A, Q or U:
   [SHIFT] DATA STEP **[↑] (KSU)**
   [FREQUENCY SPAN] [3] [0] [MHz]
   [VIDEO BW] [1] [0] [0] [Hz]
   [RES BW] [1] [0] [0] [kHz]

   For HP 11970V or W:
   [SHIFT] DATA STEP **[↑] (KSU)**
   [FREQUENCY SPAN] [1] [0] [0] [MHz]
   [VIDEO BW] [3] [MHz]
   [RES BW] [3] [MHz]

   and **[CENTER FREQUENCY]**:
   For HP 11970K: **[2] [2] [GHz]**
   For HP 11970A: **[3] [3] [GHz]**
   For HP 11970Q: **[4] [1] [GHz]**
   For HP 11970U: **[5] [0] [GHz]**
   For HP 11970V: **[6] [2] [.] [5] [GHz]**
   For HP 11970W: **[9] [2] [.] [5] [GHz]**

8. Press **[SHIFT]** and SWEEP **[CONT] (KSt)**.

9. Press **[CENTER FREQUENCY]** again and enter the appropriate center frequency as follows:

   For HP 11970K: **[1] [8] [GHz]**
   For HP 11970A: **[2] [6] [.] [5] [GHz]**
   For HP 11970Q: **[3] [3] [GHz]**
   For HP 11970U: **[4] [0] [GHz]**
   For HP 11970V: **[5] [0] [GHz]**
   For HP 11970W: **[7] [5] [GHz]**

10. Record the center frequency in Table 3-8.

11. Set the power meter CAL FACTOR to the value shown on the sensor calibration label for the center frequency indicated on the spectrum analyzer.

12. Set the signal generator output to produce a CW signal near the center of the spectrum analyzer display. Next, set the signal generator output power level to produce a reading of approximately -10 dBm on the power meter. Record the power meter reading in Table 3-8. (When testing the 11970V or W, re-zero the power meter for each measurement.)

13. Subtract the coupling factor for the directional coupler from the power meter reading, then add the power meter correction factor (dB) to the power meter reading. Record this corrected power reading in Table 3-8.

    Corrected Power Reading = Power Meter Reading - Coupling Factor + Power Meter Correction Factor.
    For example:
    (-10.03 dBm) - 9.82 dB + 0.73 = -19.1 dBm

14. On the HP 8566A/B, press MARKER **[PEAK SEARCH]**, then **[MKR→REF LVL]**. Record the marker amplitude in Table 3-8.

15. Move the marker to the displayed noise floor, or turn off the CW signal, and record the marker amplitude in Table 3-8. (Some sources may have excessive wide band noise when the RF signal is turned off, so that the noise floor must be measured with the signal left on.)

NOTE

Step 15 requires a signal source with a wide band phase noise characteristic that is at least 6 dB better than the measured average noise level.

16. The Average Noise Level is calculated as follows:

    Average Noise Level = Corrected Power Reading (step 13) - Marker Amplitude (step 14) + Marker Amplitude (step 15) - Measurement Bandwidth Correction Factor

    HP 11970K, A, Q and U Bandwidth Correction = 10log(100kHz/1kHz).
    HP 11970V and W Bandwidth Correction = 10log(3MHz/1kHz).

    For example: Average Noise Level = (-19.1 dBm) - (-32.3 dBm) + (-77.7 dBm) - 34.77 dB = - 99.3 dBm

    Enter the calculated value in Table 3-8.

    The Average Noise Level must be less than:
    -110 dBm for the HP 11970K
    -108 dBm for the HP 11970A
    -104 dBm for the HP 11970Q

-104 dBm for the HP 11970U
-92 dBm for the HP 11970V
-85 dBm for the HP 11970W

17. Enter the following pushbutton commands on the HP 8566A/B:

MARKER [OFF]
[REFERENCE LEVEL] [0] [+dBm]

18. Repeat steps 9 through 17 at the following center frequencies:

HP 11970K: 22 and 26.5 GHz
HP 11970A: 33 and 40 GHz
HP 11970Q: 41 and 50 GHz
HP 11970U: 50 and 60 GHz
HP 11970V: 62 and 75 GHz
HP 11970W: 92 and 110 GHz

19. Repeat steps 1 through 18 for a power level of 16.0 dBm at the HP 11970 Mixer LO connector.

Table 3-8. Average Noise Test Record

AVERAGE NOISE LEVEL

Model Number _____ Date _____
Serial Number _____ Tested by _____

	Center Frequency	Power Meter Reading	Power Meter Correction Factor	Directional Coupler Coupling Factor	Corrected Power Reading	Signal Marker Amplitude	Noise Floor Marker Amplitude	Bandwidth Correction Factor	Average Noise Level
Units	GHz	dBm	dB	dB	dBm	dBm	dB	dB	dBm
Step	10	12	13	13	13	14	15	16	16
LO Power = 14.5									
LO Power = 16.0									

SECTION IV SERVICE

MAINTENANCE

The only maintenance required for the Model 11970 Series Mixers is preventive maintenance. When you are not using your mixer, cover its waveguide input with its waveguide cap. Also, though the Model 11970 Mixers can absorb more punishment than is normal for such devices, you should avoid subjecting them to unnecessary shock or vibration. If you have the wooden case HP 11969A, you should keep the mixers in it when they are not in use.

REPAIRS

Except for replacement of the SMA connectors, the HP Model 11970 Mixers are **NOT** field-repairable. If your mixer fails, **DO NOT** try to repair it yourself, you will void the warranty. Instead, notify the nearest HP office.

REPLACEABLE PARTS

Replaceable parts for the mixers are limited to the SMA connectors and waveguide caps. These items and the accessories available for use with the mixers are listed with their part numbers in Table 4-1.

REPLACEMENT OF SMA CONNECTORS

If you must replace an SMA connector, Hewlett-Packard recommends that you use the Hermetic Connector Installation Tool manufactured by the M/A-COM Omni Spectra Corporation of Merrimack, New Hampshire. This is a one-piece tool specially designed for removing and installing SMA type connectors. A complete set of instructions for its use is supplied with it. See Table 4-1 for the manufacturer's part number.

CIRCUIT DESCRIPTION

A schematic diagram of a Model 11970 Series Harmonic Mixer is shown in Figure 4-1. The mixer circuit employs two diodes arranged as an anti-parallel pair. These diodes are the termination for the open end of the waveguide output. By employing a matched diode pair, even harmonic mixing is enhanced while odd harmonic mixing is suppressed.

The waveguide input is exponentially tapered in both height and width. The height taper provides impedance matching between the high impedance waveguide input and the low, dynamic impedance of the diodes. The width taper creates a high-pass filter response which isolates the LO harmonics from the

standard-height waveguide. Without this isolation, the LO harmonics would reflect from the standard-height waveguide back into the mixer and destructively interfere with the desired mixing product.

LO harmonics are confined to the immediate vicinity of the diode pair by the low-pass filter, which has as its first element a metal-insulator-semiconductor (MIS) capacitor. This improves the out-of-band response. The diplexer separates the 3 - 6 GHz LO signal from the 321.4 MHz IF signal.

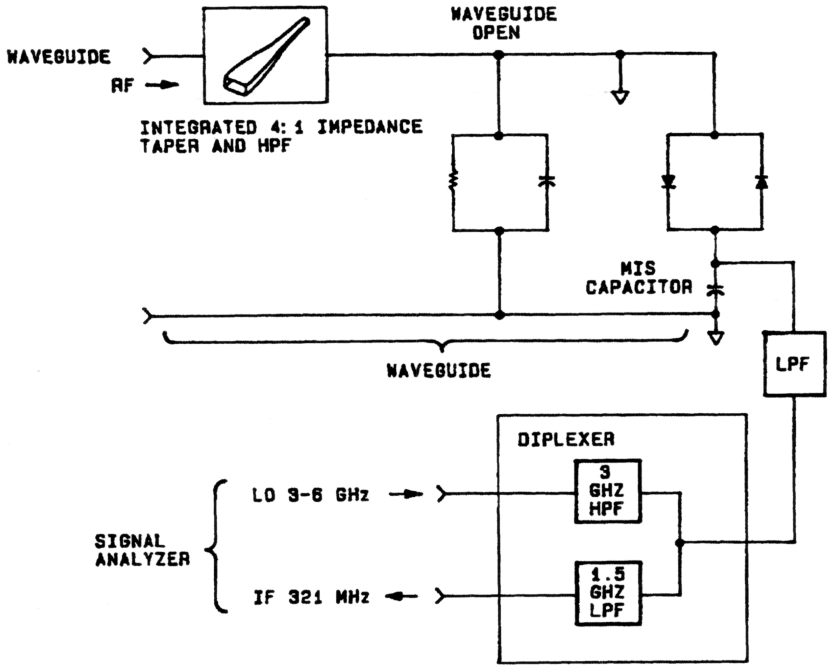


Figure 4-1. HP 11970 Series Mixer Schematic Diagram

Table 4-1. Accessories and Replaceable Parts

HP Part Number	CD	Description
5061-5460	1	Mixer Connector Kit (Option 009, includes the following three items)
5061-5458	7	Cable, 1 meter long, SMA male connectors (3 required)
8710-0510	2	Wrench, 5/16-inch, open-end
8710-1539	7	Ball Driver, 3/32-inch
5061-5459	8	Storage Case, with packing foam (HP 11969A)
3030-0221	5	Socket Head Cap Screw, 4-40 thread, .375 inches long (flange connecting screw for HP 11970K and HP 11970A)
1390-0671	9	Socket Head Cap Screw, captive, 4-40 thread, .290 inches long (flange connecting screw for HP 11970Q, HP 11970U, HP 11970V or HP 11970W)
11970-40001	7	HP 11970K Waveguide Cap
11970-40002	8	HP 11970A Waveguide Cap
11970-40003	9	Waveguide Cap for HP 11970Q or HP 11970U
5041-3932	6	Waveguide Cap for HP 11970V or HP 11970W
1250-1802	4	SMA Connector, for IF and LO connector replacement
		For Replacing SMA Connectors:
		Hermatic Connector Installation Tool, M/A-COM Omni Spectra Corporation, Merrimack, New Hampshire, M/A-COM Omni Spectra part number 2098-0248-54.